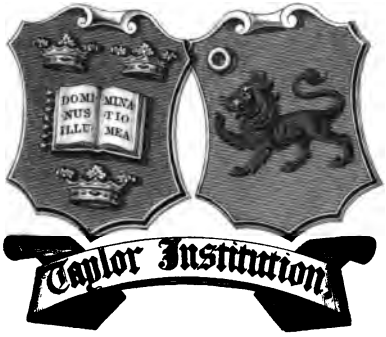

ON

GEOLOGY

IN RELATION TO THE

STUDIES OF THE UNIVERSITY

OF

OXFORD.

BY

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NOTICE.

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ON GEOLOGY, IN RELATION TO THE STUDIES OF THE UNIVERSITY OF OXFORD.

It has always appeared to me that there is a great deal of truth in an epigrammatic sentence which I once heard uttered,—that "a well educated man ought to know something of everything and everything of something." In other words, he ought to have a certain general acquaintance with the principles and outlines of all, or at least of a great many, branches of knowledge, and he ought also to select *some one,* or at most *some few,* subjects of study, of which he should endeavour to obtain the entire mastery. Without the former, most of the ideas which circulate in general literature and general conversation, become to him a dead letter, as unsuggestive as the inscriptions of Assyria or Etruria; without the latter, he possesses no detailed or systematic knowledge to exercise his judicial or discursive powers. Both general and particular knowledge are necessary to complete the mental structure;—the man who *only* knows "something of everything" is superficial, while he who *only* knows "everything of something" is narrow-minded.

So intense in some minds is the appetite for special knowledge, that they waste their energies in striving to master the entire details of every subject that comes before them, forgetting the shortness of life, and the limited powers of the human mind. Of such men it has been said that science is their *forte*, but omniscience is their *foible*. It often demands no little judgment to make a wise selection of special subjects of study, and great self-denial in adhering steadily to them. The particular duties, talents, and tastes of each individual must be consulted. The subjects which have a practical bearing on his social and professional duties must of course have the first claim for his selection. But there are few men who could not, if they would, spare with advantage a portion of their leisure from their daily employments, in order to refresh their minds with some more abstract subject of study, and nothing can more conduce to preserve the *mens sana in corpore sano* than such a change of intellectual occupation.

The principles above stated have been instinctively recognized, with greater or less precision, by the founders of Universities in modern times. They have endeavoured, theoretically at least, to give the chief prominence to those studies which concern all men as members of a Christian and a civilized community, and they have also not forgotten to provide for the acquisition of all or most other accessible branches of knowledge. Their idea of a University, as implied by its very name, was that of a microcosm, or epitome of

universal knowledge, as far as it is attainable by the faculties of man. The entire Cosmos, the *omne scibile* of all external things, was supposed to be concentrated and reflected within our collegiate walls, as the features of a boundless landscape are condensed into the narrow limits of a *camera obscura.* All men were thus enabled to enlarge their minds by acquiring the general principles of every science, while each individual had the means of mastering the profundities of such especial subjects as best suited his tastes and talents.

It is needless to say that no academical body has ever yet thoroughly carried out the details of this theoretical scheme. Yet every institution deserving of the name of University has embodied the idea above explained with greater or less success. Our own Oxford exhibits some deficiencies and some redundancies in her machinery for instruction, but all the most essential parts of the apparatus are established and in working order. The chief thing wanted is a more general appreciation, among our members, of the many pleasurable and invigorating sources of knowledge, both subjective and objective, which the Universe supplies, and of the ample facilities which our University possesses for conducting these streams of knowledge from their fountains in external nature to the mental soil which they are ever ready to irrigate. This place furnishes libraries, museums, professorships and lecture-rooms in abundance;—the trees are loaded with fruit, but too many of us neglect to gather it.

Although my especial purpose in this Essay is to

point out the claims of GEOLOGY to a conspicuous place among the studies of this University, yet I have no wish to assign to it any greater importance than it really possesses. I fully admit that Moral Science has a higher claim on our attention than Physical Research, but I only maintain the expediency of superadding to our graver studies a general acquaintance with the principles of physical science. Every man who goes forth from our Colleges into the outer world ought to carry with him a certain amount of these general elements of knowledge,—or he cannot be called a thoroughly educated man. And if his personal talents and tastes incline him to plunge deeper into any particular branch of science, to aim at knowing the "everything" of this especial "something,"—let him not lose the golden opportunity which the facilities of this place and the intervals of his academical leisure afford. Many a man, when immersed in after life in the ceaseless bustle of the world, has regretted the hours of unprofitable idleness which he might have devoted to fruitful study in our lecture-rooms and libraries.

The claims of Physical Science as an important part of the studies of Oxford are the more urgent when we consider the great dignity and influence to which it has attained in other places. It is highly inexpedient and even dangerous for us practically to ignore many matters upon which vast masses of able and energetic minds, both British and foreign, are actively employed. Now, if we look around us we shall find that though in

past times metaphysical or mathematical science were almost exclusively pursued, and physical knowledge either misunderstood or repudiated, the present age is doing its best to restore the balance of these sciences. When compared with past ages, the living generation may, to some, appear too exclusively absorbed in physical enquiries, but if this be true of the practical men of our day, it is surely not so in the case of our philosophers. These fully appreciate the excellence of mental, moral, and abstract science, and only differ from the great minds of other days in also allowing a duly adjusted influence to the sciences which treat of external and tangible objects. And as Physical Science is taking its rightful place among its compeers, so are its several subdivisions daily becoming more justly estimated, as they become better understood. By the employment of strict observation and sound Logic, Chemistry has become developed out of Alchemy, and Astronomy out of Astrology. Sciences such as Zoology and Geology, whose names were unknown a century ago, because their practical utility was less obvious than that of some others, are now cultivated and honoured. Flourishing societies are established for their promotion, and authorized teachers for their diffusion, while vast libraries and museums are the fruit and the proofs of the amount of scientific energy which has been thus put in motion. Sciences once despised by the vulgar because they were supposed to be useless and unprofitable, and only pursued by a few self-devoted and earnest truth-seekers, are now heaping

a thousand benefits on the many in return for the disinterested labours of the few. The steam-engine, the railway, the electric telegraph, and countless other temporal blessings which we now enjoy, would never have existed if the *cui bono* cavillers of past times (a race not yet extinct) had succeeded in annihilating those physical investigations, the results of which no one could foresee.

The great extent to which the different physical sciences mutually illustrate each other, has been a further cause of their being more equitably appreciated in modern times. Sciences of minor interest or dignity themselves are found to throw an important reflected light upon others, and the more the laws of Nature are studied the more evident becomes the complex net-work of relations which connects each department of knowledge with all the rest. The meanest objects cannot be despised or ignored without detriment to the highest.

Such, then, being the direction in which multitudes of active minds are ceaselessly working elsewhere, it surely behoves the University of Oxford to give a little more attention to these matters than she has hitherto done. With the means at her command, there is no reason why her fame should not be increased by original researches and physical discoveries such as those which throw lustre on London, Edinburgh, Berlin, Paris, and countless other foci of civilization. And possibly, while sharing in the intellectual reputation which has been earned by the physical labourers

of other Universities, Oxford might acquire an additional renown by giving a right direction to these studies;—guiding them by the mechanism of her Logic, and by the light of her Ethics, and thus avoiding alike the mysticism of Germany and the materialism of France.

Having said thus much on the motives for a general cultivation of the physical sciences in this place, I will now proceed to speak more especially of Geology. This is a science which occupies a peculiarly central position in relation to the rest. Chemistry, Zoology, Botany, Mineralogy, Crystallography, Electricity, Magnetism, Hydrostatics, Dynamics, Astronomy, Geography, may all derive light and life and strength from Geological research, or may communicate them in return. And if from the Sciences we proceed to the Arts, we find that Agriculture, Metallurgy, Mining, Engineering, Architecture, to say nothing of the more æsthetic arts of Painting and Sculpture, may all be aided by a knowledge of Geological principles, or may suffer from their neglect.

Geology is the science which treats of the present structure of the Earth, and of the past causes which have produced that structure. It is, therefore, a science at once of observation and of inference, of induction and of deduction. It begins by observing, collecting, and generalizing facts, and it proceeds to reason from effect to cause, and to draw conclusions as to the former conditions through which our planet has arrived at its present state. Geology may, there-

fore, be divided into two distinct departments, positive or descriptive; and inferential or dynamical. Positive Geology, or the observation of the actual phenomena presented to us by Nature, is of course the most fundamental branch of the subject. To learn what to observe, and how to observe it, to classify under general and well-selected heads the facts thus collected, is the main business of the Geologist. But it is impossible for the human mind to stop here. *Cognoscere res* is not enough for man,—he is irresistibly impelled a step further, and endeavours, if he does not always succeed, *rerum cognoscere causas*. In the case of Geology this is often a difficult undertaking, and one which requires in the reasoner an extensive knowledge of facts, and a patient and unprejudiced examination of them in all their bearings, before he ventures to draw conclusions. The phenomena are palpable to our senses, but the causes which produced them operated chiefly in the bowels of the earth or in the depths of the ocean. Even had man existed contemporaneously with those causes, they would have been in great measure concealed from his sight and consequently inexplicable by his reason. But in point of fact the vast majority of the phenomena which the Geologist investigates are due to operations which took place long anteriorly to man's existence, at periods when the physical conditions of the earth were very dissimilar to those of our own day. Our conclusions as to these past events in the earth's history are therefore frequently incapable of demonstration, they are at best but theories, which we

maintain and believe on the understanding that they are liable to occasional modification from the accession of fresh observations.

In some respects, however, we are far better able to infer the nature of causes now extinct, than a contemporaneous observer could have been. Preadamite Geologists, had such existed, could neither have penetrated to the foci of volcanoes nor to the abysses of the sea. The earthquakes which elevated the Alps would have brought death to the bystander, and the most ardent zoologist would have quailed in the presence of a living Ichthyosaurus or Iguanodon. But in the present more tranquillized state of our planet these obstacles do not exist. On the cool summits of Dartmoor or the Grampians we may examine at our ease the mode in which the molten granite was elaborated far in the interior of the earth. In Headington quarries and on Shotover Hill we may walk dry-shod on the ancient bed of the sea, and investigate the growth of coral reefs and the accumulation of detritus. The voracious monsters of former days are now the tenants not of our forests, but of our museums, where we may reason in security upon the structure of their skeletons, and infer the forms of their living bodies, together with their food, their habits, and their affinities to other creatures. So circumstantially minute, so irresistibly convincing, are many of the evidences afforded by Geology, that we may often derive from them valuable conclusions as to what is now taking place in regions of our globe inaccessible to us. By examining the dykes and intrusive

veins of trap rocks, the columnar structure of basalt, and the alterations made by igneous matter on contiguous sedimentary strata, we may pronounce with approximate certainty as to the actual condition of things at vast depths below Vesuvius or Etna. By examining the rock surfaces and the gravel ridges in the vallies of Wales or Cumberland, we learn of mechanical processes which take place on the lower surfaces of Alpine glaciers. And in our stone-quarries or our railway cuttings we gain a clearer idea of the deposition of drifted materials, the aggregations of living animals, and many other submarine phenomena, than we can ever hope to do by actual inspection of what is now taking place. In this way the past and the present mutually illustrate each other.

The theoretical department of Geology has fallen into undue discredit from the absurd inventions, the crude guesses, and illogical inferences of Whiston, Burnet, and a host of cosmogonists of former centuries. But all who have deserved the name of geologists in modern times have pursued a totally different method from those visionaries. By a strictly Baconian induction of facts, and by a comparison of the effects produced by causes now in operation with those resulting from agencies once active but now extinct, they have succeeded in giving to their conclusions an amount of probability which practically amounts to positive certainty. When arrived at by these sound principles, the theories of Geology become valuable auxiliaries to the practice. Ours were indeed a dry and

mentally unprofitable pursuit, if it were restricted to the mere collecting of specimens, the measuring of strata, and the delineation of sections. But when from these data we proceed to generalize, a far higher and nobler series of faculties are called into action. From the examination of the effect we are led to study the cause, and the modes and conditions under which it has operated. A comparison of causes, and a consideration of their various aspects and conditions, leads to the discovery of Laws of Nature which were previously unknown ; laws which have been in force since the earliest ages of our planet, but which have been hidden from man until these latter days—and lastly, from these laws of Nature we are led to the perception and appreciation of Design. We discover as an absolute fact, demonstrable to our senses, that Creative Wisdom and Providential Benevolence is unchanged by the lapse of time. In the long succession of races of organized beings which have peopled the earth through past epochs, we see variety of action, but unity of purpose ; the aspect of Nature changing, but not her laws ; the exits of old actors, and the entrances of new on the stage of organic existence, but the adaptation of their structures to the surrounding circumstances remaining the same. An immense and an unlooked for accession has thus been made to the unanswerable phalanx of arguments by which Natural Theology is defended. Dr. Buckland's Bridgewater Treatise has completed the task which Paley had begun, and a quibbling mysticism is now the only resource of the sceptic and the atheist.

Nor is it going too far to assert, that not merely Natural Theology, but even Revealed Religion, may derive support from the evidence which Geology unfolds. Paley's argument that the proofs of Design which Nature exhibits, demonstrate the existence of a Designer, will serve to confute the Atheist, but are not equally efficacious with the Deist. There are men who admit that a Creation implies an original Creator, yet who refuse to allow that any fresh manifestations of the Creator's power have operated in the lapse of Time or in the changes of Circumstance. They can only conceive a Creation called into being by the Divine fiat, and then left for ever to the guidance of eternal Laws. They cannot believe in a Providence watching over the working of His vast machine, and correcting its irregularities by special acts of interposition. They refuse all assent to recorded testimonies of such interpositions, however well authenticated, because, say they, Miracles are contrary to Experience.

Now, Geology alone, it would seem, of all the Physical Sciences, is commissioned to declare to Man, what Revelation declares in another language, that Miracles are *not* contrary to Experience, or at least *not* contrary to Fact. The other sciences deal with the properties of matter as they are, irrespectively of past Time. But Geology treats not only of the Present, but of the Past, not merely of Phenomena which exist, but of Events which have successively taken place. It is in fact a department of History, and only differs from what is commonly so termed, in treating chiefly, though

by no means entirely, of events anterior to Man's existence. Now, although in the Inorganic department of Geology we perhaps find that the Past is strictly conformable to the Present, and that the Laws of Nature, though they may once have operated on a greater scale than now, present no signs of change or even of suspension, yet when we turn to Organic Nature, a very different result is exhibited. We there see unmistakeable proofs of frequent suspension of the Laws of Nature, and of special interpositions of Creative power. It is a law of Nature, and, as far as mere human experience goes, a constant one, that organic beings, animal and vegetable, are produced only from a pre-existing parent. Equivocal generation, or the spontaneous conversion of inorganic matter into an organic tissue, is now exploded as a fallacy, and "omnia ex ovo" is established as an every day truth. Yet unquestionably true as this principle is within the limited span of Man's observation, it is no less certain that in the vastly larger cycles of Geological Time, this law has undergone frequent suspensions. There have been occasions when whole races of Animals and of Plants have ceased to propagate their kind, and have become extinct. And to meet these losses in the treasury of Nature, new species, new genera, new orders and classes of animals and plants, which had no previous existence whatever, were suddenly called into being, to fill existing voids, and to provide for new complications of external circumstances. Such direct interpositions of Almighty Power are in every sense supernatural and

miraculous. How grateful Butler would have been could the state of Science of his day have supplied him with this important addition to the Analogies of Natural and Revealed Religion! This is no *à priori* or *ex parte* conclusion, drawn with a view to the support of natural or revealed religion. It is simply the logical result of a great physical problem, a result to which nearly all the greatest physical philosophers who have grappled with the subject have been compelled, willingly or unwillingly, to arrive. I need only mention the names of Cuvier, of Agassiz, of Owen, of Lyell, of Sedgwick, as a few examples of the host of witnesses who might be cited in support of this proposition.

An unsound, if not a morally perverted, school of reasoners may try to reduce these manifestations of Infinite Power to the domain of Natural Law, but in vain; their plausible sophistry vanishes before the appliances of sound Logic[a]. The records of a Mighty Creator acting independently of Law, at successive epochs, are engraven on the strata of the everlasting hills, and it is the high privilege of the Geologist to interpret their testimony. Beyond this point Geology does not go. She has reached the limit of her own domain, and she leaves it to the theologian to pursue

[a] In our own country these doctrines have recently gained some popularity from that specious, but most shallow publication, the *Vestiges of Creation*. To those who may have been in the slightest degree influenced by its perusal, I would strongly recommend the study of the *new edition* of Prof. Sedgwick's Discourse on the Studies of the University of Cambridge, and the equally able "Footprints of the Creator" of Mr. Hugh Miller.

the subject further. On this point I may quote the words with which Dr. Whewell concludes his able discussion of the relations in which Physical Science stands to Theology:—

"From what has been said it follows that Geology and Astronomy are of themselves incapable of giving us any distinct and satisfactory account of the origin of the Universe or of its parts. We need not wonder, then, at any particular instance of this incapacity, as for example the impossibility of accounting by any natural means for the production of all the successive tribes of plants and animals which have peopled the world in the various stages of its progress, as Geology teaches us. That they were, like our own animal and vegetable contemporaries, profoundly adapted to the condition in which they were placed, we have ample reason to believe, but when we enquire whence they came into this our world, Geology is silent. The mystery of creation is not within her legitimate territory; she says nothing, but she points upwards."

It is also no slight enhancement of the interest which Geology possesses in our eyes, that it is pre-eminently a progressive science. Far be it from me to say that any branch of knowledge is not progressive. The human faculties have not yet, and perhaps never will, attain the extreme limits of any field of enquiry, nor if they reach the margin, will they ever wholly exhaust the soil of the interior. Still, some sciences have come into existence, and have attained to excellence at very different periods from others. Geology is one of the youngest born, and is but just attaining to the vigour of maturity. Men are now living in whose youth Geology, viewed as a science and not as a speculation, had no real existence. Its grandest discoveries, and its sublimest generalizations, are the work of our own genera-

tion, and are yet far from completion. This, which may be called an accident and not a property of the science, is yet unquestionably a source of its great vitality at the present moment. Our intellectual faculties derive both pleasure and instruction from contemplating a science growing before our eyes, receiving and reflecting back new lights from surrounding sciences, and pointing the way to undiscovered truths.

It is in this respect especially that Geology claims a position among the appropriate studies of this place. Erudition, and not discovery, necessarily forms the staple employment of our youth, and the physical sciences are therefore valuable, precisely because of the contrast they present to classical learning. A change of diet is as necessary for mental as for bodily health. If our chief business in this University is to acquire a knowledge of the results at which the master minds of antiquity have long since arrived, it must also be a beneficial, though subordinate, exercise to learn the right methods to discover new truths, and to assist in discovering them for ourselves.

If mathematical studies discipline the mind to sound reasoning, physical science is no less useful in supplying a habit of exact observation. A correct syllogism is worse than useless if its premisses be false, and the greater the powers of reasoning in a man, the more dangerous they become, unless the reasoner possesses a sufficient stock, a mental capital, of general and particular truths. Now, though physical science does not supply Man with all the truths that he requires, it dis-

ciplines him in the art of acquiring the rest. It teaches him to be ever striving for the greatest attainable amount of certainty, to apply his powers of observation to the utmost, and to appreciate the minutest details of quantity, quality, or relation, in their influence on the general result.

These advantages attach more or less to the study of any physical science, and to none more so than to Geology. A man cannot become a good geologist without acquiring at least a general knowledge of most other branches of Physics, and there is, therefore, no fear of his mind becoming narrowed by an exclusive devotion to one pursuit. To be a geologist, he must study Mineralogy, and this implies an acquaintance with the principles of Chemistry, and of Crystallography, with its attendant train of geometrical investigations. Hypogene geology, or the department which treats of volcanic operations, of earthquakes, and the elevation or depression of the earth-crust, leads to a series of dynamical researches highly interesting to the mathematician, such as those which have recently been pursued with great success by Mr. William Hopkins of Cambridge. The connection between Geology and Astronomy is also evident, for while Astronomy studies the forms and motions of *all* the heavenly bodies, Geology investigates that *one* of them which happens to be the most accessible to ourselves. Nor, indeed, is Geology wholly confined to our own planet, for the telescope supplies us with some highly important information regarding the geological structure of the Moon, and to

a certain extent of other bodies of the Solar System. The other branches of Physics, such as Electricity, Terrestrial Magnetism, and that highly interesting subject, Physical Geography, which the labours of Humboldt, of Ritter, of Mrs. Somerville, and of Guyot, have recently elevated to the rank of a science, have all an intimate connection with Geology. If we turn to the sciences which treat of organic life, Zoology and Botany, we find (what we had no reason to expect *à priori*) that they actually form a part of Geology, and Geology of them. The fossil remains which have been disinterred from the cemeteries of past epochs, have almost doubled our actual knowledge of the forms of animal and vegetable life, and have filled up innumerable gaps which were otherwise apparent in the chain of organized existences. In short, there is hardly a department of physical science which does not in some way or other illustrate Geology, or receive illustration from it.

This wide extent of scientific relations, which Geology exhibits, may perhaps deter some from the pursuit. They may suppose that a long course of physical science must be gone through before a man is fit to commence this study. The fact is, however, that geology rather leads to, than presupposes, a knowledge of the other sciences. A thorough acquaintance with chemistry, zoology, or botany, is doubtless the best groundwork for the study of geology, yet it is equally certain that a sufficient knowledge of these may be acquired, collaterally with an advancement in geological

science. No one can have studied the latter subject diligently, without gaining incidentally, a considerable knowledge of the principles of the other physical sciences; and should he afterwards wish to pursue any one of them more in detail, he will be all the better qualified for so doing.

Much advantage may also be gained by means of the division of labour, a principle to which we owe so much of our modern refinement and civilization. If the geologist wishes to analyze a specimen, he may take it to a chemist, whose practised hand will at once supply the required information. So if he is in doubt about the name or structure of a fossil shell he consults one naturalist, of a fossil coral, another, of a fossil plant, a third. In this way he readily acquires an amount of information, to arrive at which independently a lifetime would be too short. With zoologists like Owen, Mantell, Forbes, Lonsdale, Egerton, Waterhouse, with botanists like Lindley, Bunbury, and Hooker, with such chemists as Faraday, Playfair, or Graham, and with mathematicians like Herschel, Hopkins, or Babbage, we possess in this country a phalanx of scientific referees, competent to the solution of any practicable geological problem.

Geology is, indeed, a science of a peculiarly comprehensive range of vision. It is not like many other sciences confined to mere *matter*, but extends its flight through *time*, and through *space*. It directs a telescopic, as well as a microscopic glance upon its subject matter, just as a painter after labouring at the minute details of

a portrait, finds it necessary from time to time, to retire to a distance, and take a general survey of his whole design. Thus a Geologist finds his advantage in sometimes laying aside his hammer, or his microscope, and retiring to the mountain top, where the distant prospect not only gives him that refined pleasure which is common to all men, when contemplating the majesty of Nature, but also supplies positive geological information of the most valuable kind. Or even if travelling rapidly by railway, he may still cultivate his favourite science, and acquire general views, which the stonequarry does not supply. The geographical and picturesque features of a country, the forms of the hills and valleys, the direction of the streams, the botanical and agricultural produce, the social and moral condition of the people, are all closely connected with the geological structure of the district which he traverses, and will therefore legitimately engage his attention.

I need not enlarge on the important relations in which geological science stands to the practical employments of life, which in the present state of our civilization have become so widely multiplied. There is no profession which may not derive advantage from combining a knowledge of this subject with its more especial studies. The connection of geology with mining and engineering operations is self-evident, and is now generally recognized. The architect will render his structures all the more durable, if he possesses a scientific knowledge of the strata on which he builds, and of the material which he employs. The medical man will

acquire more enlarged, and more correct views of the influence of localities upon diseases, if he comprehends those geological idiosyncracies on which the configuration of the surface depends. Military men will be the better able to fortify their positions, and to comprehend the natural defences of a country, by acquainting themselves with its geological structure. The artist will view with additional delight, the picturesque features of the landscape, if he understands the geological agencies of which that landscape is the result. The agriculturist will be more likely to derive profit from his draining and manuring, by an acquaintance with the composition, the inclination, and the superposition of the strata which underlie his fields. The politician and statistician must be informed as to the geological structure of a country, before they can explain or remedy many anomalies in the wealth, the industry, the morality, and other social phenomena of particular districts. And, lastly, the clergy, who form the larger portion of the students annually reared, and sent forth from this place, will derive much benefit, and no detriment, by an acquaintance with the principles of geological science. Natural Theology is an appropriate adjunct to Revealed Religion, and a study of the works of the Deity in antecedent ages of the Earth, cannot be inconsistent with a devout contemplation of the dealings of God with Man. It is also no small advantage to a studious or laborious ecclesiastic to have an inducement for taking exercise in the open air, and refreshing the mental faculties by the contact of external nature. Many of our clergy

too are destined to pass their lives in remote parishes, far from educated neighbours, and where their parochial duties are too light to occupy their whole time. The monotony of such a position will often, in spite of the best principles, re-act upon the nerves, and render a person listless, if not discontented. To a mind thus diseased, I can prescribe no better remedy than this:— "Make a geological map of your parish. Form a collection of all its animal, vegetable, and mineral productions. Read the books which will teach you their names and classification. When this is done, extend your researches to the neighbouring parishes, or to the whole county. If this alterative treatment be combined with an earnest discharge of your sacred duties, the result cannot fail to be beneficial."

But there are higher reasons which make it incumbent on our clergy to acquire some knowledge of physical science, and especially of geology. This science has demonstrated in a manner which cannot be gainsaid that the earth is of a vast and untold antiquity, and that Man is but as a thing of yesterday, compared with the successive races of animated beings which have peopled the ancient world. This unexpected discovery has naturally surprised, if not alarmed, many sincere champions of revelation. As long as no proof appeared to the contrary, men acquiesced from ancient times in that which appeared the most obvious interpretation of the Mosaic History, namely, that the creation of the Heavens and of the Earth was nearly coincident with that of Man, and that these wondrous mani-

festations of Almighty Power, bear a date of some 6000 years ago. Now, however, when it can be proved that vast epochs of animated existence preceded the advent of the human race, it is evident that some modified interpretation of the few brief words which commence the book of Genesis must be admitted.

All truths must be consistent with each other, and in order to retain the Mosaic narrative as a portion of inspired truth, a re-interpretation of the passages in question appears indispensable. Those, therefore, to whose keeping the inspired records are especially entrusted, are bound to make themselves acquainted with both sides of the argument.

The different forms in which Universal Truth is exhibited to our view, such as Physical, Moral, and Religious, may be compared to a cluster of hill fortresses, all in view from one another, each one serving either as a protection to the rest, or as a point of attack against them, according to the motives of the men who garrison it. Now it is unquestionable that there have been, and that there are, men who would gladly seize on the eminences of physical science, as a vantage ground from which to direct their batteries against revealed religion. But if the champions of revelation will pre-occupy those eminences, they may so fortify them as to protect the Church of Christ from her foes.

An able writer of the present day speaks thus of the expediency of combining physical science with theological studies :—

"The mighty change which has taken place during the present century in the direction in which the minds of the first order are operating, though indicated on the face of the country in character which cannot be mistaken, seems to have too much escaped the notice of our theologians. . . . Judging from the preparations made in their colleges and halls, they do not now seem sufficiently aware,—though the low thunder of every railway, and the snort of every steam engine, and the whistle of the wind amid the wires of every electric telegraph, serve to publish the fact, that it is in the department of physics, not of metaphysics, that the greater minds of the age are engaged—that the Lockes, Humes, Kants, Berkeleys, Dugald Stewarts, and Thomas Browns belong to the past, and that the philosophers of the present time,—tall enough to be seen all the world over, are the Humboldts, the Aragos, the Agassizes, the Liebigs, the Owens, the Herschels, the Bucklands, and the Brewsters. In that educational course through which, in this country, candidates for the ministry pass, in preparation for their office, I find every group of great minds which has in turn influenced and directed the mind of Europe for the last three centuries, represented, more or less adequately, save the last. It is an epitome of all kinds of learning with the exception of the kind most imperatively required, because most in accordance with the genius of the time. The restorers of classical literature—the Buchanans and Erasmuses we see represented in our Universities by the Greek and what are called the humanity courses, and the Lockes, Kants, Humes, and Berkeleys by the metaphysical course. But the Cuviers, the Huttons, the Cavendishes, and the Watts, with their successors the practical philosophers of the present age,—men whose achievements in physical science we find marked on the surface of the country in characters which might be read from the moon, — are *not* adequately represented;—it would perhaps be more correct to say that they are not represented at all; and the clergy as a class suffer themselves to linger far in the rear of an intelligent and accomplished laity,—a full age behind the requirements of the time. Let them not shut their eyes to the danger which is obviously coming. The battle of the evidences will have as certainly to be fought on the field of physical science, as it was contested in the last age on that of the metaphysics. And on this

new arena the combatants will have to employ new weapons, which it will be the privilege of the challenger to choose. The old, opposed to these, would prove but of little avail. In an age of muskets and artillery the bows and arrows of an obsolete school of warfare would be found greatly less than sufficient in the field of battle, for purposes either of assault or defence."—Hugh Miller, Footsteps of the Creator, p. 21.

The physical and practical tendencies of the present age, the importance of which, as a matter of fact, is so impressively urged in the above passage, have received a very marked impulse even in the short period since those words were written. The Great Exhibition of 1851 has tended in a very great degree to enhance and diffuse the social influence of practical industry, and of the physical sciences which lie at its foundation. The millions who visited that marvellous display of human energy have carried home a fund of objective ideas which will influence their future lives. And many of the raw materials and manufactured results of industry there assembled have since been placed in permanent repositories for the informa ion of future generations.

The Museum of Practical Geology in Jermyn Street has not only received many accessions of this kind from the Great Exhibition, but has within these few months assumed the form of a geological college, in which the several branches of Chemistry, Mechanical Science, Natural History and its Applications, Geology and its Applications, Mining, Mineralogy and Metallurgy, are now regularly taught by Professors of the highest scientific eminence. This noble institution, which no visitor to London should omit to inspect, together with

the collections of the British Museum, of the College of Surgeons in Lincoln's Inn, and of the Geological Society in Somerset House, furnish a strong evidence of the high estimation in which the physical sciences, and especially those which cluster round Geology as a centre, are now held by the Government and by the Nation.

I fully grant that for a people so busied with practical matters as ourselves, it is a high privilege to possess, by way of counterpoise to these utilitarian tendencies, a few ancient Universities like Oxford, where Classical Learning, Moral Science, and pure Theology may be cultivated for their own sakes. But I see no reason why our Universities should exclusively devote themselves to these abstract studies. It is surely beneficial both to our intellectual and moral faculties, as well as conducive to our social interests, to inform ourselves of many matters which exert a great practical influence on the external world, and among these Geological Science occupies a conspicuous place.

In regard to the influences of Geology as a moral and intellectual discipline, I may quote the words of Dr. Whewell, who in his History of the Inductive Sciences, thus speaks of Geological studies :—

The labours of the members of the Geological Society " have shown that there are no talents and no endowments which may not find their fitting employment in this science. Besides that they have united laborious research and comprehensive views, acuteness and learning, zeal and knowledge ; the philosophical eloquence with which they have conducted their discussions has had a most beneficial influence on the tone of their speculations ;

and their researches in the field, which have carried them into every country and every class of society, have given them that prompt and liberal spirit, and that open and cordial bearing, which results from intercourse with the world on a large and unfettered scale. It is not too much to say that in our time, practical geology has been one of the best schools of philosophical and general culture of mind."—Whewell, Hist. Ind. Sc., vol. iii., p. 524.

Nor should we forget how greatly the pleasures of travelling are enhanced by a knowledge of physical science, and especially of Geology. Oxford sends forth annually scores of active-minded and strong-bodied men who seek to enliven the Long Vacation, or the interval between their B.A. degree and their assumption of a profession, by exploring distant lands. With the present facilities of locomotion neither the North Cape, nor Abyssinia nor the Mississippi are too remote for their enterprise. Possessed of such opportunities, what gratification would they not derive, and what additions would they not make to human knowledge, were they but grounded, even in a moderate degree, with the elements of physical science. Instead of merely gratifying a thirst for adventure and excitement, they would acquire the purer and more wholesome love of knowledge, and would return enriched with a stock of mental acquirements which would supply them with material for pleasing thought and for active usefulness during the rest of their lives.

To such men any branch of natural history would furnish an invaluable resource, and none more so than Geology, a science which so admirably combines the

general with the special—the enlarged views of the physical geographer with the minute researches of the zoologist, botanist, and mineralogist.

Such are some of the many grounds which recommend Geology to the attention of the Members of this University. I may add that there are few places possessed of greater local advantages for studying the science. The Geological Museum in the Clarendon, for which the University is mainly indebted to the untiring energy and great liberality of Dr. Buckland, presents an immense and very precious collection of specimens from formations of every age and from all parts of the world. It is true that the space now assigned to this collection is very inadequate for its proper display, but this defect we may hope ere long to see remedied by the erection of a suitable Museum for these and other materials connected with physical science. Meanwhile the Geological collection, though confined in space, yet presents a quite sufficient amount of systematic arrangement for purposes of general instruction, with which view it is opened gratuitously to Members of the University three days in every week. Two courses of Lectures on Geology will henceforth be delivered in this Museum, while to those who wish to go deep into the subject, the recently established School of Natural Science will afford the means of academic distinction. In the Radcliffe Library we possess nearly every standard work on Geological science, accessible without fee or reward to every Student who may wish to consult it. And, lastly, in the district around

Oxford we may read in the Book of Nature one of the most instructive chapters of Geological history. In the short distance between Steeple Aston on the north, and Shotover or Cumnor Hills on the south, we may examine in succession the Lias, the Marlstone, the Inferior Oolite, the Stonesfield Slate, the Great Oolite, the Cornbrash, the Oxford Clay, the Coral Rag, the Kimmeridge Clay, the Portland Stone, and the Wealden Sands;—each formation marked by its peculiar mineral and physical characters, and still more so by its numerous and beautifully preserved organic remains, differing in every stratum, and telling us of the lapse of countless ages, and of wondrous changes in the animal population of the earth. Or if we take the rail and travel an hour's journey to the east we ascend to the Green Sand, the Chalk, and the London Clay, while by passing west to Bristol we may descend from the Lias and New Red Sandstone to the lower depths of the Coal Measures, the Carboniferous Limestone, and the Devonian series. All this vast succession of formations is now brought within the easy access of a few hours' excursion from the doors of our Colleges.

Let me hope, in conclusion, that the junior Members of the University will cease to overlook the treasures of knowledge which lie beneath their feet, and will be induced to give a larger portion of their leisure and of their energies to the cultivation of some of those branches of knowledge, of which no man ever yet repented the acquisition.

FINIS.